

# Description

## Antenna with Rotatable Reflector

### BACKGROUND OF INVENTION

[0001] 1. Field of the Invention

[0002] The invention relates to antennas. More specifically, the invention relates to a highly directional rotatable antenna module suitable for use, for example, with consumer multi-channel multi-point distribution systems (MMDS).

[0003] 2. Description of Related Art

[0004] MMDS are useful for communications and or entertainment. A consumer may have several MMDS sources from which to choose from and each of the different MMDS sources may not always be available/in service. To select between sources and or obtain the best possible signal strength, a user may be required to access, reposition and or redirect an antenna.

[0005] Rotatable antennas, for example TV antennas equipped with rotators, have previously used motors to allow a user to remotely point the antenna to a desired azimuth direc-

tion where the strongest signal for a desired channel/frequency is available. However, because the antenna feed is rigidly coupled to the antenna, rotation is limited to a 360 degree (or less) span with a stop and associated sensors for disabling the motor when the stop is reached from either direction. Where a rotator with a stop is used, to move between one side of the stop and the other, the antenna must be reversed across its full sweep causing a period of interrupted reception. Rotatable antennas with a full sweep, for example surveillance radar antennas, require use of a rotary joint or similar rotatable feed coupling on the antenna feed connection, which increases costs and introduces an opportunity for signal losses.

[0006] Competition within the antenna industry has created a need for antennas that are configurable for remote redirection having minimized materials and manufacturing costs.

[0007] Therefore, it is an object of the invention to provide an antenna, which overcomes deficiencies in the prior art.

#### **BRIEF DESCRIPTION OF DRAWINGS**

[0008] The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate embodiments of the invention and, together with a general

description of the invention given above, and the detailed description of the embodiments given below, serve to explain the principles of the invention.

- [0009] Figure 1 shows a partial cut-away isometric view of a first embodiment of the invention.
- [0010] Figure 2 shows a top section view of the first embodiment of the invention.
- [0011] Figure 3a shows a first side (front) view of an antenna element of the first embodiment of the invention.
- [0012] Figure 3b shows a second side (back) view of an antenna element of the first embodiment of the invention.
- [0013] Figure 3c shows a first side (front) view of an antenna element of the first embodiment of the invention, with hidden lines to show the alignment of transmission lines and ground traces located on either side of the antenna element.
- [0014] Figure 3d is a close up view of a section of the antenna element of the first embodiment of the invention, identifying dimensions and interspacing of the conductive layers which form the antenna element.
- [0015] Figure 4 shows azimuth angle test performance data of the first embodiment of the invention.
- [0016] Figure 5 shows elevation angle test performance data of

the first embodiment of the invention.

## DETAILED DESCRIPTION

- [0017] As shown in figures 1 and 2, an antenna 1 may be optimized for use with MMDS signals. A Radio frequency (RF) transmissive radome 10 encloses a fixed omni-directional antenna element 20. An RF reflector 30 formed from an RF reflective material, for example metal or metal coated material, is arranged proximate the omni-directional antenna element 20 to receive and/or transmit RF from/into a desired direction. The RF reflector 30 may be mounted on a rotatable gear 40 driven by a motor 50, for example a stepper motor. Alternatively, the motor 50 may be configured for direct drive, coupled to the RF reflector 30 at the axis of rotation and located at the end opposite from the antenna element 20 feed connection.
- [0018] An angle of the RF reflector 30 may be adjusted larger or smaller to configure the azimuth directional characteristic of the antenna 1. Alternatively, the RF reflector 30 may be formed with a shape configured for a desired azimuth pattern, for example, a parabolic or elliptical curve. In these configurations, the antenna element 20 may be generally positioned at a focus point of the elliptical or parabolic curve. Elevational coverage of the antenna may

be adjusted by adding RF absorbing elements 60 and or additional reflectors at either end of the RF reflector 30.

[0019] Because the RF reflector 30 rotates enclosed within the radome 10, the reflector 30 and associated structure need not be reinforced to resist wind loading and therefore may be formed of relatively lightweight materials. The rotatable gear 40 may be keyed to rotate about a low friction bearing surface with a locating shoulder, for example a plastic bearing ring 45. A center pin may be located at the top of the radome 10 to operate as a guide for the rotation of the RF reflector 30, allowing further reduction in the structural requirements of the RF reflector 30. As the rotating assembly is lightweight, a relatively inexpensive low torque motor 50 may be used.

[0020] A first embodiment of the omni-directional antenna element 20 is formed from conductive layers or trace(s) 70 on a printed circuit board (PCB) 80. As shown in Figures 3a-d, the conductive layers form a series of microstrip transmission line 87 sections along the length of the PCB 80. As shown in Figure 3c, at each transition between sections, the transmission line 87 sections become the ground plane 85 trace of the adjacent section on the other side / alternate layer of the PCB 80 and vice versa. In the

first embodiment, these overlaying sections are separated by 10 small radiating gaps "G" that serve as omni-directional radiating gap elements, forming a linear antenna array as will be appreciated by those familiar with the microstrip antenna arts. Alternatively, any number of transmission line sections and radiating gap elements could be used. The spacing "d" between gap "G" centers in Figure 3d may be uniform along the array, and may be selected to be half a guide wavelength for the microstrip line at or near the desired center frequency of operation. Alternatively, other spacings may be used, including non-uniform spacing between radiating gap(s) "G". The radiating gap "G" and ground plane 85 widths "W" shown in Figure 3d are adjusted to control the electrical parameters of the radiating gap "G", namely, the load admittance presented to the microstrip transmission line 87, as well as the radiation pattern. Similarly, the gap "G" and ground plane 87 widths "W" may be varied or uniform along the array.

- [0021] In the first embodiment, the array is terminated in a short circuit 88 located a distance "T" approximately one-quarter guide wavelength of the microstrip line away from the center of the last radiating gap "G", forming a stand-

ing-wave array. Those skilled in the art will appreciate that the line could also be terminated in a matched load, or some similar impedance. As indicated in Figures 3a and 3b, in the first embodiment the microstrip transmission line 87 and microstrip ground 85 traces at the connector end are electrically coupled, for example by soldering, to the inner conductor 95 and outer conductor 97, respectively, of a feed connection 90.

- [0022] Antenna element 20 embodiments using trace(s) 70 on PCB 80 allow a plurality of different configurations, each tuned to a desired frequency or frequency band, to be quickly and cost effectively produced for use with the same surrounding components. Further, antenna tuning circuitry, for example capacitors, inductors and or resistors may be economically added to the PCB 80 for antenna impedance and or q-factor tuning.
- [0023] In alternative embodiments the generally omni-directional antenna element 20 may be configured, for example, as a single dipole, linear array of dipole or dipole pair elements. The antenna element 20 need not be formed using a PCB 80; a stamped metal element, coil or other form of antenna structure may be applied as desired.
- [0024] Because the omni-directional antenna element 20 is fixed

in place, a low signal loss and inexpensive direct feed connection 90, for example, a standardized coaxial connector may be used. In alternative embodiments, the antenna element 20 may be coupled to diplexer, transceiver and or receiver circuits contained in the antenna 1 assembly.

- [0025] As shown in figures 4 and 5 the antenna 1 may be configured to have directional azimuth coverage (figure 4) in any desired direction by actuating the motor 50 to rotate the gear 40 and associated RF reflector 30 about the antenna element 20. Elevational coverage (figure 5), adjustable for example via the selected antenna element 20, reflector 30 and or RF absorbing elements 60, is fixed throughout the azimuth range.
- [0026] The radome 10 may be configured to provide an environmental seal for the internal components and or a minimized wind load. Also, the radome 10 operates to conceal mechanical operation and or fragile components of the antenna 1, making it suitable for use / installation by untrained consumers.
- [0027] Integrated with a receiver and or transceiver system, the motor 50 may be automatically or manually controlled to seek a specific signal and or the signal providing the

strongest signal strength, which once detected may be focused in upon by selective positioning of the RF reflector

30. Because the control of the motor 50 may be via remote electrical control, the antenna 1 may be located in a remote location providing the best reception characteristics, for example at a high point on a structure or within an attic space.

[0028] **Table of Parts**

10	radome
20	antenna element
30	RF reflector
40	gear
45	bearing ring
50	motor
60	RF absorbing element
70	trace
80	PCB
85	ground plane
87	microstrip transmission line
88	short circuit
90	feed connection
95	inner conductor
97	outer conductor

- [0029] Where in the foregoing description reference has been made to ratios, integers or components having known equivalents then such equivalents are herein incorporated as if individually set forth.
- [0030] While the present invention has been illustrated by the description of the embodiments thereof, and while the embodiments have been described in considerable detail, it is not the intention of the applicant to restrict or in any way limit the scope of the appended claims to such detail. Additional advantages and modifications will readily appear to those skilled in the art. Therefore, the invention in its broader aspects is not limited to the specific details representative apparatus and method, and illustrative examples shown and described. Accordingly, departures may be made from such details without departure from the spirit or scope of applicant's general inventive concept. Further, it is to be appreciated that improvements and/or modifications may be made thereto without departing from the scope or spirit of the present invention as defined by the following claims.